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HEPATICAE OF PUERTO RICO

XI. DIPLASIOLEJEUNEA

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(WITH PLATES 16 AND 17)

In the tenth paper of this series* three genera of the Lejeuneae are discussed in which underleaves are entirely absent. In the genus *Diplasiolejeunea* the underleaves are duplicated; in other words an underleaf is developed for every lateral leaf, instead of for every pair of lateral leaves (PLATE 16, FIGURES 1 and 10). The only other genus in which this peculiar condition is found is *Colura*, which contains some of the most remarkable species of the Lejeuneae. To explain the doubling of the underleaves in *Colura*, Goebel† advanced the theory that the leaves are not arranged in a three-ranked spiral, as is usual in the leafy Hepaticae, but that a postical segment is cut off from the apical cell after each lateral segment. This being the case the leaves would be arranged in a zigzag, and the imaginary line connecting their successive bases would not cross the antical surface of the stem at all. The examination of growing points in *Diplasiolejeunea* brought out the fact that Goebel's explanation would apply to this genus as well as to *Colura*. It should be noted, however, that the duplication of the underleaves is not an absolutely constant feature. The base of a branch, for example (FIGURE 10), shows the ordinary spiral arrangement, and the same thing is true of an antheridial spike throughout its entire length (PLATE 17, FIGURE 2). In the

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† Organographie der Pflanzen 286 (footnote). 1898.

involucre, also, a single bracteole is present for the pair of bracts (PLATE 16, FIGURE 1), just as in other genera of the Lejeuneae. It is evident, therefore, that the spiral arrangement of the leaves is the primitive one and that the zigzag arrangement represents a later development.

In spite of its duplicated underleaves *Diplasiolejeunea* has many characters in common with *Cololejeunea* and *Leptocolea*, in which no underleaves whatever are developed. In fact, the authors of the Synopsis Hepaticarum included in their subsection Duplicatae, which is one of the groups into which they divided their § Typicae of the genus *Lejeunea*, two species of *Leptocolea* as well as several species of *Diplasiolejeunea*. Gottsche afterwards grouped together all the Lejeuneae known to him in which the underleaves were duplicated, some of which naturally belong to the genus *Colura*.* Spruce, however, was the first to define *Diplasiolejeunea* in its present sense. He included it among the subgenera of *Lejeunea*,† but it was soon raised to generic rank by Schiffner.‡

The genus is widely distributed in tropical regions and contains about twelve species. The type species, *D. pellucida* (Meissn.) Schiffn., is abundant in America and is known also from Africa, the East Indies, and New Caledonia. Three of the other species are African, one is known from Tasmania only, and the others are American. Although the plants attain a fairly large size for members of the Lejeuneae they are delicate in texture and show little or no pigmentation. They grow on bark and on living leaves, and at least some of the species seem to be constant in their choice of a substratum.

The stems cling closely to the substratum and branch irregularly according to the usual *Lejeunea* or *Radula* type. The stems are at first scattered, but with the appearance of branches compact mats are gradually formed, the branches lying subparallel or diverging in a more or less radiate manner. The leaves are large and usually loosely imbricated (PLATE 16, FIGURES 1, 10, and 11). The lobes are attached by an exceedingly short and almost transverse

* Ann. Sci. Nat. Bot. V. 1: 164. 1864.

† Hep. Amaz. et And. 301. 1884.

‡ Engler & Prantl, Nat. Pflanzenfam. 1^3: 121. 1895.

line, very much as in *Cololejeunea* and its immediate allies. They spread widely from the axis and lie more or less appressed to the substratum, although in some species they are distinctly convex. They vary in outline from ovate to suborbicular, their apices are broad and rounded, their margins are entire or nearly so, and they tend to arch across the axis at the antical base. The cells of the lobes are plane or nearly so, and their walls are more or less thickened. In some species the thickening appears to be uniform, while in others trigones and intermediate thickenings are clearly visible. In all the Puerto Rico species ocelli are numerous and scattered throughout the lobe, very much as in the genus *Stictolejeunea*. They are found also in the perianths but seem to be constantly absent from the lobules and underleaves. In *D. pellucida* the lobes are often margined by a band of hyaline cells, but these have not been observed in the other species.

The lobule agrees in many respects with that of *Cololejeunea*. It is of a fairly large size, from one third to one half the length of the lobe, and is inflated throughout more or less of its extent. It broadens out abruptly from a narrow base and forms a distinctly arched keel with the lobe. The free margin is involute in its basal portion and sometimes for about half its length, the outer part being frequently appressed to the lobe. At some little distance beyond the middle the apical tooth is situated and is separated from the end of the keel by a shallow sinus. The tooth is remarkably well developed and shows considerable variation in form. It may, for example, be subulate and acuminate (FIGURES 1 and 5) or it may broaden out from a stalklike base into a t-shaped structure (FIGURES 10 and 13). The hyaline papilla is situated at the base of the tooth on the inner surface of the lobule. When the base of the tooth is three cells wide the papilla is on the median cell; when the tooth is two or four cells wide it is situated on one side of the median wall, sometimes on the distal side and sometimes on the proximal. In addition to the apical tooth the free margin bears a second tooth, proximal to the apex; this tooth is shorter than the apical tooth and also different in form. Between the proximal tooth and the base of the lobule one or more minute denticulations may be distinguished in certain species.

The underleaves are sometimes distant and sometimes overlap

more or less closely. They are deeply bifid with long and spreading divisions, which taper gradually to sharp or blunt apices (PLATE 16, FIGURE 1; PLATE 17, FIGURES 1 and 2). Sometimes the divisions spread so widely that the upper margin of the underleaf is bounded by an approximately straight line. At the base a distinct radicelliferous disc is usually developed (PLATE 16, FIGURE 6) and affords a firm anchorage to the substratum. The margin is practically entire although the cells in some species often project as indistinct crenulations.

So far as known the inflorescence is either autoicous or dioicous and seems to be fairly constant for a given species. The archegonium is sometimes borne on a leading branch (FIGURE 1) and sometimes on a very short branch, in many cases a single leaf and a single underleaf being the only appendages present except the involucral leaves and the perianth (FIGURE 2). The female flower seems to be invariably subtended by a single innovation. The bracts are much smaller than the ordinary leaves and are subequally bifid (FIGURE 7), the lobule sometimes slightly exceeding the lobe in length (PLATE 16, FIGURE 17, on left). The single bracteole is free and more or less bifid, the divisions sometimes spreading widely and sometimes being suberect or connivent (PLATE 16, FIGURES 1 and 11). The perianth is sharply five-keeled, although more or less compressed, and becomes suddenly contracted at the apex into a short beak. The surface is apparently never roughened by teeth or projecting cells even along the keels. The antheridial spikes (PLATE 17, FIGURE 2) are much as in other Lejeuneae. They either occupy short branches or are terminal on longer branches and rarely show signs of proliferation. The bracts, which are rarely numerous, are usually diandrous. The sporophyte is essentially the same as in *Cololejeunea* and the other genera of the Lejeuneae.

The only species of *Diplasiolejeunea* that has been recorded from Puerto Rico is the type species, *D. pellucida*. The material collected by the writer includes this species and also three others, one of which seems to be undescribed. In distinguishing the species the lobules, the underleaves, the inflorescence, and the perichaetial bracts yield the best differential characters. The gemmiparous branches and the gemmae, which will be described at the close of the paper, may likewise be of service.

DIPLASIOLEJEUNEA PELLUCIDA (Meissn.) Schiffn.

Jungermannia pellucida Meissn.; Sprengel in Linnaeus, Syst. Veg. ed. 16. 4^2: 325. 1827.

Lejeunea ocellulata Mont. & Nees, Ann. Sci. Nat. Bot. II. **19**: 264. 1843.

Lejeunea pellucida Meissn. in G. L. & N. Syn. Hep. 393. 1845.

Lejeunea albifolia Tayl. Lond. Jour. Bot. **5**: 399. 1846.

Lejeunea (*Diplasio-Lejeunea*) *pellucida* Spruce, Hep. Amaz. et And. 302. 1884.

Diplasiolejeunea pellucida Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1^3: 121. 1895.

Pale green or whitish, growing scattered or in depressed mats: stems 0.07 mm. in diameter, sparingly and irregularly pinnate, the branches (except the subfloral innovations) widely spreading, similar to the stems but usually with smaller leaves: leaves loosely imbricated, the lobe obliquely to widely spreading, closely appressed to the substratum, broadly ovate, 0.85–1 mm. long, 0.7–0.85 mm. wide, antical margin rounded at the base and extending across the axis, outwardly curved to the apex, postical margin also curved, sometimes forming a vague angle at the junction with the keel, antical and apical regions often bordered by from one to four rows of hyaline cells; lobule ovate, 0.4–0.5 mm. long, 0.25–0.35 mm. wide, abruptly broadening from a narrow base, inflated throughout, keel arched, free margin more or less involute, often involving the proximal tooth, apical tooth obliquely spreading, acute, mostly three to five cells long and three or four cells wide at the base, usually tipped with a row of two or three cells, the terminal cell sometimes rounded or truncate, proximal tooth smaller than the apical tooth and usually tipped with an acute cell, hyaline papilla mostly on the distal side of the apical tooth, sinus about four cells long; cells of lobe averaging about 12μ at the margin, 23 $\times$ 20μ in the middle, and 35 $\times$ 20μ at the base, the walls more or less thickened but with vague trigones and occasional intermediate thickenings, hyaline marginal cells (when present) thin-walled: underleaves distant, rounded to cordate at the base, broadly cuneate, about 0.085 mm. long and 0.4 mm. wide, deeply bifid with widely spreading acuminate divisions, the apical sinus being very shallow or even obsolete, margin entire or subcrenulate from projecting cells: inflorescence dioicous: ♀ inflorescence borne either on a leading branch or on a very short branch, the innovation apparently continuing the floral axis and often bearing another inflorescence; bracts obliquely spreading, sharply complicate but

not winged along the keel, shortly bifid (about one third), the lobe oblong, rounded, entire, 0.5 mm. long and 0.15 mm. wide, lobule nearly as large as the lobe, acute to acuminate, sparingly and irregularly denticulate; bracteole ovate, 0.35 mm. long, 0.15 mm. wide, bifid almost to the base with suberect or often connivent or overlapping acuminate divisions and a narrow sinus; perianth obovate, 0.95 mm. long, 0.5 mm. wide, rounded at the apex and with a very short beak: ♂ inflorescence terminal on a leading branch or occupying a short branch, not proliferating; bracts imbricated, mostly in from three to ten pairs, diandrous, strongly inflated, shortly and subequally bifid with rounded divisions, the postical sometimes bluntly pointed, keel strongly arched; bracteoles similar to the underleaves but much smaller and less deeply bifid with obliquely spreading acute divisions: capsule about 0.35 mm. in diameter; spores yellowish green, minutely verruculose, about 20μ in short diameter; elaters about 12μ wide, the wall irregularly thickened. (PLATE 16, FIGURES 1–9.)

On living leaves. Puerto Rico, without definite localities, *Schwanecke, Sintenis* (*27*). Sprengel describes the type locality of *Jungermannia pellucida* in the following words, "ad filices Ind. Occid." The writer has not been able to study any of the original material but bases his conception of the plant upon a series of specimens determined by various authorities. The species occurs in two fairly distinct modifications, the second of which is described below as a new variety. The typical form may be recorded from the following additional localities in the American tropics: Cuba, *Wright;* Jamaica, *Underwood, C. E. Cummings, N. L. Britton, Evans;* Costa Rica, *Pittier;* French Guiana, *Leprieur, Perrottet;* Brazil, *Endlicher, Pabst, Spruce, Glaziou.* Material from the various collections mentioned, much of which is in the British Museum, has been examined by the writer. The specimen collected by Leprieur, however, which represents the type of *Lejeunea ocellulata*, is in the Montagne herbarium at Paris. Of African specimens two have been studied, one collected in 1814 by Beauvais at "Oware," and the other by Rodriguez on the island of Mauritius. Both agree with the American plant, so far as can be determined by the fragmentary material. The Beauvais specimens, one of which is in the Kew herbarium, represent the type of *L. albifolia*, and show a certain approach to the variety described below. As has already been noted, *D. pellucida* has been reported

also from the East Indies and from New Caledonia, but no material from these regions has been available for study.

Diplasiolejeunea pellucida malleiformis var. nov.

Apical tooth of lobule variable, sometimes as in the typical form of the species but usually t-shaped, the terminal portion consisting of from two to four cells placed at right angles to a short stalk, the latter one cell or rarely two cells wide: in other respects agreeing closely with the type. (TEXT FIGURE 1.)

On leaves, rarely on bark. El Yunque, *Evans* (*10*, *120* in part, *127* in part). The variety may also be recorded from the following stations: John Crow Peak, Jamaica, *Evans* (*135* in part); Grande Soufrière Hill, Dominica, *Elliott* (*1815*, *1816*); Laudat, Dominica, *Lloyd* (*324a* in part); St. Vincent, *Elliott* (*9*, *22*, *356*).

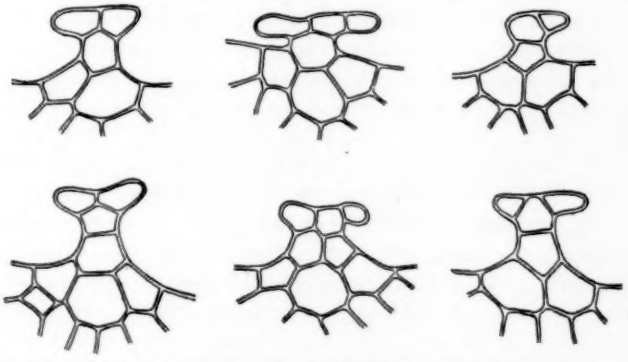

FIGURE 1. *Diplasiolejeunea pellucida malleiformis;* El Yunque, Puerto Rico, *Evans* (*10*). Apical teeth of lobules, × 300.

The t-shaped apical tooth of the lobule in this curious variety is so different from the pointed tooth in typical *D. pellucida* that a specific separation seemed at first to be indicated. Unfortunately further study soon showed that this single difference was quite unsupported by others, and also that the t-shaped tooth formed an inconstant feature, some of the specimens showing both t-shaped and ordinary pointed teeth. In the Beauvais specimens noted above, none of the teeth are distinctly t-shaped, although some are tipped by two cells placed side by side at right angles to the stalk, and the latter is occasionally two cells wide. The material from the Grande Soufrière, Dominica, is in the herbarium of the

British Museum and was referred by Stephani to his *D. armatiloba*,* a species that requires further study. It was based on sterile specimens from Guadeloupe and was regarded by Gottsche as a variety of *D. pellucida*. Unfortunately the type has not been accessible, but a specimen in the British Museum, collected by Elliott at Trois Pitons, Dominica (*1754*), and determined by Stephani, coincides closely with the original description. This plant has a dioicous inflorescence and is very much like the variety *malleiformis*, the apical tooth of the lobule being even more definitely t-shaped. The underleaves, however, have rounded or obtuse divisions, which spread obliquely.

Diplasiolejeunea brachyclada sp. nov.

Pale green or yellowish, scattered or in depressed mats: stems 0.1 mm. in diameter, sparingly and irregularly pinnate, the branches widely spreading, similar to the stem: leaves loosely imbricated, the lobe obliquely to widely spreading, not appressed to the substratum, plane or more or less squarrose in the antical portion, broadly ovate, 1.25–1.5 mm. long, 1–1.1 mm. wide, when well developed, antical margin rounded at the base and extending across the axis, outwardly curved to the apex, postical margin straight or slightly curved, forming a very obtuse angle at the junction with the keel; lobule ovate, 0.7 mm. long, 0.3 mm. wide, inflated throughout, keel arched, free margin involute at least near the base, apical tooth obliquely spreading, acute, truncate or t-shaped, mostly three or four cells long and two cells wide at the base, proximal tooth sometimes inflexed, shorter than the apical tooth and acute, hyaline papilla distal in position; cells of lobe averaging about 12μ at the margin, 27 $\times$ 18μ in the middle, and 38 $\times$ 20μ at the base, the walls thickened uniformly: underleaves distant, rounded to subcordate at the base, broadly cuneate, averaging about 0.17 mm. in length and 0.6 mm. in width, deeply bifid with obliquely spreading acute divisions and a very obtuse sinus, margin entire: inflorescence autoicous: ♀ inflorescence borne on a very short branch, a single leaf and a single underleaf being present in addition to the involucral leaves and perianth, the innovation usually simple and sterile, rarely bearing a second female flower; bracts obliquely spreading, sharply complicate but not winged along the keel, bifid about one fourth, the lobule often a little longer than the lobe, the latter oblong, 0.5 mm. long, 0.17 mm. wide, rounded at the apex, entire or vaguely and sparingly

* Hedwigia **35**: 80. 1896.

denticulate along the margin, lobule obtuse, sparingly denticulate; bracteole oblong-obovate, 0.5 mm. long, 0.3 mm. wide, bifid about one half with acute suberect divisions, entire or irregularly crenulate from projecting cells; perianth oblong or oblong-ovate, 1.2 mm. long, 0.5 mm. wide, rounded to truncate at the apex and with a very short beak: ♂ inflorescence occupying a short branch, very rarely proliferating; bracts imbricated, in from two to four pairs, similar to those of *D. pellucida;* bracteoles also similar: mature sporophyte not seen. (PLATE 16, FIGURES 10–18.)

On bark of trees. Puerto Rico: El Yunque, *Evans* (*24*, *127* in part). Jamaica: Cinchona, *Evans* (*138*, *250* in part). No. 24 may be designated the type.

This new species is closely related to *D. pellucida* but is at once distinguished by its larger size and by its autoicous inflorescence. The leaves, furthermore, always lack the hyaline border, which is so frequent in *D. pellucida*, and are never closely appressed to the substratum; in fact, they are oftentimes distinctly squarrose in the antical region. In other respects they are much alike in the two species. The underleaves yield a few additional points of distinction. In *D. pellucida* the divisions are acuminate and spread so widely that the upper margin of the underleaf is often scarcely indented in the middle. In *D. brachyclada* the divisions spread obliquely and form a distinct angle where they come together. Their apices are acute, rather than acuminate, and are usually tipped with a single cell; even when tipped with two superimposed cells they taper more abruptly than in *D. pellucida*. Apparently the female inflorescence in *D. brachyclada* is invariably borne on an abbreviated branch, but the involucral leaves and perianths show no very striking peculiarities. The antheridial spikes, also, show little tendency to vary in length. In *D. pellucida* both male and female branches are subject to marked variation in this respect.

DIPLASIOLEJEUNEA UNIDENTATA (Lehm. & Lindenb.) Schiffn.

Jungermannia unidentata Lehm. & Lindenb. in Lehmann, Pug. Plant. **6**: 48. 1834.

Lejeunea unidentata Lehm. & Lindenb. in G. L. & N. Syn. Hep. 392. 1845.

Lejeunea (*Diplasio-Lejeunea*) *unidentata* Steph. Hedwigia **29**: 90. 1890.

Diplasiolejeunea unidentata Schiffn. Bot. Jahrb. **23**: 583. 1897.

Pale green or whitish, growing in compact depressed tufts: stems 0.14 mm. in diameter, prostrate, irregularly pinnate, the branches obliquely to widely spreading, similar to the stem but usually with smaller leaves: leaves imbricated, the lobe widely spreading, somewhat convex, broadly ovate to suborbicular, 1.2–1.4 mm. long, 1–1.2 mm. wide, antical margin straight to rounded at the base, usually arching across the axis, strongly outwardly curved to the apex, postical margin also curved, forming a very obtuse or rounded indentation at the junction with the keel; lobule obovate, 0.7 mm. long, 0.4 mm wide, inflated along the arched keel, more or less appressed to the lobe in the outer portion, free margin involute near the base but usually plane otherwise, apical tooth acute, obliquely spreading, mostly three to five cells long and two or three cells wide at the base, usually tipped with two superimposed cells, proximal tooth much shorter and often inconspicuous, acute to rounded, hyaline papilla mostly distal, sinus shallow, forming a distinct angle with the apical tooth; cells of lobe averaging 18μ at the margin, 28 × 18μ in the middle and 32 × 18μ at the base, more or less thickened and usually with distinct trigones and occasional intermediate thickenings: underleaves distant to subimbricated, broadly cuneate, 0.2 mm. long in the middle, 0.5–0.6 mm. wide, bifid about one half with obliquely spreading divisions, obtuse to rounded at the apex, sinus mostly acute, margin entire: inflorescence dioicous: ♀ inflorescence borne on a leading branch or on a more or less abbreviated branch, the innovation mostly simple and sterile; bracts obliquely spreading, sharply complicate and sometimes very narrowly winged along the keel, bifid one third to one half, the lobe oblong, 0.6 mm. long, 0.25 mm. wide, rounded at the apex, entire, lobule similar in form, 0.5 mm. long, 0.22 mm. wide, rounded to very obtuse at the apex, margin entire; bracteole ovate, 0.45 mm. long, 0.35 mm. wide, bifid about one third with acute suberect divisions and an entire margin; perianth as in *D. pellucida*, 1.3 mm. long, 0.75 mm. wide: ♂ inflorescence occupying a short branch, not proliferating; bracts mostly in from three to six pairs, similar to those of *D. pellucida;* bracteoles also similar: mature sporophyte not seen. (PLATE 17, FIGURES 1–12.)

On bark, rarely on leaves. El Yunque, *Evans* (*2*, *120* in part, *145*). The species is known to the writer from the following additional localities: Mansfield, Jamaica, *Evans* (*336*); Sharford Estate, Dominica, *Elliott* (*1601*); Martinique, *Duss;* St. Vincent, Herb. Hooker, the type station.

The present species and the following, *D. Rudolphiana*, have been so much confused that a brief account of their history may not be out of place. *Jungermannia unidentata* was originally described from a specimen in the Hooker herbarium, collected on the island of St. Vincent. A portion of this original material is preserved at Kew, and although it is perfectly sterile it agrees so closely with the other plants cited above that there can be but little doubt that they represent the same species. A similar specimen from the Lehmann herbarium is in the Montagne herbarium at Paris. In 1845 Montagne reported *D. unidentata* from Cuba, his record being based on specimens collected by Ramon de la Sagra.* He also published figures of these specimens, and since his time *D. unidentata* has been listed from a number of localities in tropical and subtropical America, many of the determinations being apparently based on these figures. A careful study of Montagne's specimens, however, has shown that the Cuban plant is not the same as the type specimen in the Hooker herbarium, and that some of the published records for the species are therefore incorrect, a fact which the writer has already noted elsewhere.† The Cuban plant, however, does not represent an undescribed species. It agrees closely with *D. Rudolphiana*, and the same thing is true of some of the other specimens that have been referred to *D. unidentata*.

In the opinion of Spruce,‡ *D. unidentata* ought to be considered as a variety of *D. pellucida*, but there are many reasons for regarding them as distinct species, in spite of the fact that both are dioicous. *D. unidentata* is a more robust plant than *D. pellucida*, it grows normally on bark and not on leaves, it is much less closely appressed to the substratum, its leaves always lack hyaline borders, and the leaf cells usually show distinct local thickenings in their walls. The underleaves, too, present a very different appearance. The divisions spread obliquely, forming a distinct sinus, and their apices vary from obtuse to rounded instead of being acuminate. In the involucre the bracteole is much less deeply bifid than in *D. pellucida*, and the lobes are consequently broader

* In Ramon de la Sagra, Hist. Fis. Pol. y Natur. Cuba **9**: 478. *pl. 19. f. 2.* 1845.

† Bull. Torrey Club **38**: 207. 1911.

‡ Hep. Amaz. et And. 302. 1884.

and less sharply pointed; the perianth, however, is essentially the same. When compared with *D. brachyclada*, the dioicous inflorescence, the absence of t-shaped apical teeth on the lobules, the distinct local thickenings in the cell walls, and the blunter divisions of the underleaves will serve as distinguishing characteristics.

DIPLASIOLEJEUNEA RUDOLPHIANA Steph.

Lejeunea unidentata Mont. in Ramon de la Sagra, Hist. Fis. Pol. y Natur. Cuba **9**: 478. *pl. 19. f. 2.* 1845. Not Lehm. & Lindenb.
Diplasiolejeunea Rudolphiana Steph. Hedwigia **35**: 79. 1896.

Yellowish or brownish green, growing in compact depressed tufts: stems 0.12 mm. in diameter, sparingly and irregularly pinnate, the branches widely spreading, similar to the stem but usually with smaller leaves: leaves imbricated, more or less convex, the lobe widely spreading, broadly ovate, 1.2–1.4 mm. long, 1–1.2 mm. wide, antical margin rounded at the base, arching across the axis, strongly outwardly curved to the apex, postical margin likewise curved, forming a rounded indentation at the junction with the keel, margin entire or vaguely and sparingly crenulate from projecting cells; lobule obovate, 0.7 mm. long, 0.35 mm. wide, inflated in carinal region or throughout, keel arched, free margin involute near the base but usually plane elsewhere, apical tooth long and slender, subparallel with the axis or obliquely spreading, usually from six to eleven cells long and two cells wide at the base, proximal tooth shorter but sharp and distinct, often inflexed, usually tipped with a row of two or three cells, hyaline papilla distal; cells of lobe averaging 15μ at the margin, 28 × 22μ in the middle, and 37 × 25μ at the base, walls slightly thickened showing small trigones and very rare intermediate thickenings: underleaves distant to subimbricated, broadly cuneate, 0.17–0.2 mm. long in the middle, 0.4–0.6 mm. wide, bifid about one half with a rounded sinus and obliquely spreading divisions, mostly rounded at the apex but occasionally obtuse or subacute, margin as in the leaves: inflorescence autoicous: ♀ inflorescence borne on an elongated branch or on a very short branch, the innovation usually simple and sterile; bracts obliquely spreading, strongly complicate and very narrowly winged along the keel, bifid two thirds to three fourths, the lobe oblong-obovate, 0.4 mm. long, 0.17 mm. wide, rounded, margin vaguely crenulate from projecting cells, lobule oblong, 0.35 mm. long, 0.12 mm. wide, obtuse to subacute, margin as in the lobe; bracteole ovate, 0.35 mm. long, 0.25 mm. wide, bifid one fifth to one third with acute

to obtuse suberect divisions, margin as in the bracts; perianth much as in *D. pellucida*, 1.3 mm. long, 0.5 mm. wide: ♂ inflorescence occupying a short branch, not proliferating; bracts mostly in from three to six pairs, similar to those of *D. pellucida;* bracteoles also similar: mature sporophyte not seen. (PLATE 17, FIGURES 13–17.)

On bark of trees. Near Cayey, 1900, *Evans* (*96* in part, *102*). The writer has examined specimens from the following additional localities: near Camp Longview, Florida, *Small & Wilson* (mixed with *2058*); various stations on New Providence, Bahama Islands, *Coker, E. G. Britton;** Cuba, *Ramon de la Sagra, Wright;* near Port Margot, Hayti, *Nash* (*165*); Troy, Jamaica, *Evans* (*658*); Paramaribo, Dutch Guiana, *Kegel;* Petropolis, Brazil, *Rudolph*, the type locality. The portion of the type that was studied is in the herbarium of the British Museum and agrees closely with the other specimens cited.

Although the geographical distribution of *D. Rudolphiana* is by no means thoroughly known, it seems to be the dominant representative of the genus in the lowlands of tropical America. It is often associated with the presence of man and occasionally occurs at higher altitudes along roadsides and in plantations. In this respect it resembles the common *Frullania squarrosa* (R., Bl. & N.) Dumort. It is closely related to *D. unidentata* but differs from it in two important particulars, its autoicous inflorescence and the remarkable development of the apical teeth of its lobules. The teeth form a very characteristic feature of the plant, even if poorly developed branches sometimes fail to show them in a typical condition. When well developed the apical tooth attains a length of about ten cells and is two cells wide for at least half its extent. It occupies a position parallel with the axis, and this is due, sometimes at least, to a curve at the base. The portion of the lobule from which the tooth arises shows an almost straight edge, the tooth forming a distinct angle on each side. The base is usually four cells across and the hyaline papilla is borne on the outer of the two median cells. The proximal tooth, also, is unusually long and distinct but is sometimes strongly inflexed and difficult to demonstrate. Between the proximal tooth and the

* Bull. Torrey Club **38**: 207. 1911.

base one or two minute teeth, each consisting of a single projecting cell, can sometimes be distinguished. In cases where the apical tooth spreads obliquely, as in *D. unidentata*, it shows the same complexity as when parallel with the axis. Aside from the peculiarities just noted *D. Rudolphiana* is much like *D. unidentata*, and almost the same differential characters will serve to separate it from *D. pellucida* and *D. brachyclada*.

VEGETATIVE REPRODUCTION IN DIPLASIOLEJEUNEA

The vegetative reproduction in *Diplasiolejeunea* is carried on by means of discoid gemmae, which bear a marked resemblance to those found in the genera *Cololejeunea*, *Leptocolea*, and *Aphanolejeunea*. These gemmae have been demonstrated in *D. pellucida* (including the variety *malleiformis*), in *D. unidentata*, and in *D. Rudolphiana*. They have not yet been observed in *D. brachyclada*, however, and it is therefore possible that they are associated with certain species and never produced by others.

In *D. pellucida* the gemmae are borne on the lower surface of ordinary leaf lobes (TEXT FIGURE 2, *A*) and seem to be entirely absent from bracts and perianths. They occur on plants of either sex but tend to be more frequent on male individuals. In some cases the leaves on one side of a gemmiparous axis will develop gemmae much more abundantly than the leaves on the other side. Apparently the production of gemmae has no marked effect on the growth of the shoot, and the leaves upon which the gemmae are borne show no modifications. In *D. unidentata* and *D. Rudolphiana* the gemmiparous branches are very different from those of *D. pellucida* and much more highly specialized. They show a definite limitation in growth, and the gemmae are restricted to the youngest leaves that reach maturity, in most cases to the terminal pair of leaves (PLATE 17, FIGURES 1 and 3). These leaves differ considerably from normal leaves. Instead of being plane or convex, when examined from above, they are distinctly concave in the apical portion; and instead of spreading widely from the axis they spread very slightly. They are also relatively narrower than normal leaves, although sometimes larger. The modifications in the lobule affect chiefly the apical tooth, which is distinctly shorter than on normal leaves (FIGURE 6) and tends to be

nearer the outer extremity of the free margin. The hyaline papilla occupies the usual position but no proximal tooth is developed. The gemmae, which are produced in great abundance, are confined to the apical portion of the lobe, but are situated on the lower surface as in *D. pellucida*.

The development of the gemmae is essentially the same as in *Cololejeunea* and its allies, so that only the most important features of the process need be mentioned. The establishment of the mother cell of the gemma, the division into quadrants, and the greater growth of the apical quadrants take place as described by Stevens for *Cololejeunea Biddlecomiae* (Aust.) Evans.* In the same way each apical quadrant proceeds to divide as a two-sided apical cell and cuts off two series of segments, the first division wall being parallel with the median wall of the gemma. The segmentation, however, is carried considerably further, the number of segments being usually from seven to ten. It will be remembered that five is the highest number of segments observed in *Leptocolea*. The gemma shown in TEXT FIGURE 2, *B* has ten

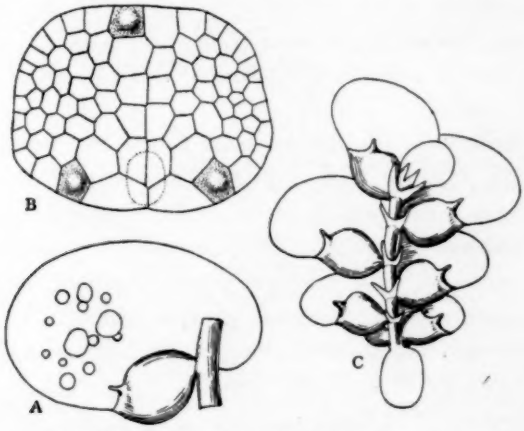

FIGURE 2. *Diplasiolejeunea pellucida;* Morce's Gap, Jamaica, *Evans* (55). *A*. Gemmiparous leaf, postical view, × 40. *B*. Gemma, × 300. *C*. Germinating gemma, postical view, × 40.

segments on the left-hand side and nine on the right-hand side. The subsequent divisions in the segments are largely by periclinal walls, as many as three such walls appearing in some of the older

* Bull. Torrey Club **37**: 366–369. *f. 1.* 1910.

segments. In the younger segments, however, there is often an anticlinal wall formed in the most external cell. So far as observed the basal quadrants always divide by a single periclinal wall. The attachment of the gemma is markedly excentric, and the separation takes place just as in *Cololejeunea*, a slightly projecting stalk cell being left behind.

The curious organs of attachment, noted in the genera *Cololejeunea*, *Leptocolea*, and *Aphanolejeunea*, are developed also in the gemmae of *Diplasiolejeunea*. In the vast majority of cases there are three such organs on each gemma. One arises from the outermost cell of one of the oldest segments on one side of the median wall, while the other two arise from the outermost cells of the second segments cut off from the apical quadrants. In a single instance a gemma with four organs of attachment was observed, one arising in each of the oldest segments. It will be noted that in contrast to *Cololejeunea* and its allies the basal quadrants play no part in the development of the organs of attachment. The mature gemma consists of an oval plate of cells broader than long. The margin is entire, and the apical cell in each half is clearly visible, being sometimes situated in a slight depression. The gemmae in *D. pellucida*, *D. unidentata*, and *D. Rudolphiana* are essentially alike.

The germination follows the same course as in *Cololejeunea*, one of the apical cells of the gemma functioning directly as the apical cell of the leafy shoot without the interpolation of a thalloid structure (TEXT FIGURE 2, *C*). The leaves at the base of the shoot are rudimentary and have no corresponding underleaves, but the characteristic features of the genus are very quickly acquired. In one case both apical cells had given rise to shoots, but one was much better developed than the other.

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Explanation of plates 16 and 17

The figures were drawn by the writer and prepared for publication by Mr. Stanley C. Ball.

PLATE 16

Diplasiolejeunea pellucida (Meissn.) Schiffn. 1. Part of a plant, showing a perianth borne on a leading branch, postical view, × 25. 2. A short branch bearing a female inflorescence, postical view, × 35. 3. Cells from middle of lobe, the dotted line representing the thickness of the wall about halfway between the two leaf surfaces, × 265. 4. Cells from margin of lobe, × 265. 5. Apex of lobule, × 200. 6. Part of an underleaf, × 200. 7, 8. Bract and bracteole from a single involucre, × 45. 9. Transverse section of a perianth above the middle, × 35. The figures were all drawn from specimens collected by the writer at Morce's Gap, Jamaica (*55*).

Diplasiolejeunea brachyclada Evans. 10. Part of a plant showing two female inflorescences and a male spike, postical view, × 25. 11. Part of a plant with a perianth and an antheridial spike, postical view, × 25. 12. Cells from middle of lobe, × 265. 13. Apical portion of a lobule, × 200. 14. Apical tooth of another lobule, × 200. 15. Apex of an underleaf division, × 200. 16–18. Bracts and bracteole from a single involucre, × 45. The figures were all drawn from specimens collected by the writer, FIG. 11 being from the type specimen (*24*), and the others from *no. 127*.

PLATE 17

Diplasiolejeunea unidentata (Lehm. & Lindenb.) Schiffn. 1. Female branch with perianth and innovation, the latter gemmiparous, postical view, × 25. 2. Part of a plant with two antheridial spikes, postical view, × 25. 3. Apical portion of a gemmiparous branch, postical view, × 25. 4. Cells from middle of lobe, × 265. 5. Apical portion of a lobule, × 200. 6. Apical portion of the lobule of a gemmiparous leaf, × 200. 7–9. Apices of underleaf divisions, × 200. 10–12. Bracts and bracteole from a single involucre, × 45. The figures were all drawn from specimens collected by the writer, FIG. 1, 10, 11, and 12 being from *no. 2*, and the others from *no. 145*.

Diplasiolejeunea Rudolphiana Steph. 13. Part of a leading axis, postical view, × 25. 14. Apical region of a lobule, × 200. 15–17. Bracts and bracteole from a single involucre, × 45. The figures were all drawn from specimens collected by G. V. Nash near Port Margot, Hayti (*165*).

A taxonomic study of the Pteridophyta of the Hawaiian Islands—

WINIFRED J. ROBINSON

(WITH PLATES 18–20)

The following paper is a partial result of the study of ferns and fern allies of the Pacific Islands, which was begun several years ago under the direction of the late Professor Lucien M. Underwood, whose design was to combine the regional taxonomic studies of a number of workers in a comprehensive report which should include ecological and morphological features as well. To the writer was assigned the taxonomic study of the Hawaiian fern flora.

The Hawaiian Islands lie at the crossroads of the Pacific, latitude 18° 55′–22° 15′ north, longitude 154° 50′–160° 30′ west, more than two thousand miles from San Francisco and about the same distance from the nearest islands to the southwest. They are farther from the mainland than any other group of islands of the same extent; and while a geodetic map shows that they have arisen by volcanic action through a fissure in the earth's crust, which extends from northwest to southeast, there is nothing to indicate that they were ever connected by a chain of islands with Japan, and there is very little in common in the floras of Japan and Hawaii. Hence their isolation must have been as complete through the ages as it is now. With the exception of coral limestone along the shore and a little sandstone and sedimentary rock, the soil is uniformly of basaltic origin. Kauai, geologically the oldest island of the group, about 2,000 m. high at its highest point, is most eroded and deserves its name of the garden island. Hawaii, with two snow-capped peaks, Mauna Kea and Mauna Loa, each nearly 5,000 m. high, and with its active volcano, Kilauea, is still in the making. The ridges are steep and the valleys narrow in all the islands. As a rule the northeast side of the island is covered with rain forest, while the southwest or lee side is arid because of the direction of the prevailing winds.

These winds together with the ocean currents make the temperature of the Hawaiian Islands several degrees lower than that of the West Indies, which are in the same latitude. At sea level it ranges from 16° to 30° C., while at an elevation of 365 m. it is about 20° C.

There are few wild plants in the islands that seem to owe their origin to northwest America, though a pine log of great size, evidently brought by the North Pacific Drift Current, has been known to reach the island of Maui. A correspondence between a number of South American and Hawaiian forms has been traced among flowering plants, but the affinities of the ferns seem to be with those of the islands to the southwest rather than with those of the mainland, while a large number of species are endemic. The extreme lightness of the spores makes their suspension in currents of air for long periods possible, and also may account for their transfer over great distances. In prehistoric times the journey of two thousand miles from the Society Islands was probably made several times in open boats, and since ferns were used in the religious rites of the islanders, some species may have been introduced in this way.

The material for this study consisted of the collections in the herbarium of the New York Botanical Garden (indicated by C), that of the Royal Botanical Garden at Berlin, Germany (indicated by B), the Bernice Pauahi Bishop Museum at Honolulu, H. I. (indicated by BM), the National Herbarium at the Smithsonian Institution, Washington, D. C. (indicated by N), and the herbarium of Vassar College, Poughkeepsie, New York (indicated by V). In a few cases comparisons have been made at Kew through the kindness of Mrs. N. L. Britton of the New York Botanical Garden (indicated by K). The writer spent seven weeks in the Hawaiian Islands, in the summer of 1909, in collecting ferns and observing ecological factors of their habitat.

When Captain Cook made his last South Sea voyage in 1776–9, during which he discovered the Hawaiian Islands, he was accompanied by David Nelson, who made collections of ferns and other plants, now preserved in the herbarium at Kew, that of the Linnean Society of London, and that of the British Museum. Landings were made upon Kauai and Nihau in January 1778,

but the men did not remain long enough to permit exploration at any considerable distance from the shore. In November 1778 Captain Cook returned and spent ten weeks in cruising about Maui and Hawaii, making frequent landings, hence it is probable that the greater portion of Nelson's collection is from these islands.

At Kew there are also preserved specimens from the collections of Archibald Menzies, surgeon and naturalist upon Vancouver's voyage of 1790–95. Some of his specimens have reached the herbarium of the New York Botanical Garden by exchange with Kew. Vancouver's policy in dealing with the natives was so just that he secured their confidence and his men were able to explore freely. He spent about four months upon the islands.

In 1816–17 Albert Chamisso, while on the voyage of the Romanzoff, made collections of plants in Oahu and published his notes and descriptions of new species in Linnaea. His collections are at Berlin, in the herbarium of the Royal Botanical Gardens.

In 1819 Charles Gaudichaud, botanist of the French Corvette l'Uranie under Captain Freycinet made collections upon the islands, and published his account of plants in Botanique du Voyage d'Uranie, in 1830 (1826 according to the title page). He returned to the Hawaiian Islands in 1826 as botanist on the Bonite, but the only record of his collections consists of a few plates with no adequate descriptions or notes as to localities where the plants were found.

James Macrae, afterward superintendent of the Ceylon Botanical Gardens, made collections in the Pacific Islands and in South America between the years 1824 and 1826. His collections have been variously distributed by exchange and appear in herbaria in Great Britain, the Continent, and America.

In 1826–7 George T. Lay and Alexander Collie, the collectors with Captain Beechey on the voyage of the Blosssom, secured the specimens from which Hooker and Arnott made their report of the Botany of Captain Beechey's Voyage, 1830–41.

In 1833 David Douglas, sent out by the London Horticultural Society, made valuable collections of Hawaiian ferns, which are preserved in the herbaria of Hooker, Bentham, and Lindley. Douglas met his death in Hawaii by falling into a pit which was intended to entrap animals.

The United States Exploring Expedition under Captain Wilkes visited the Hawaiian Islands in 1840. Brackenridge, the botanist of the expedition, published his descriptions of ferns as a separate volume of the report of the expedition, but unfortunately the edition with the exception of about a dozen copies was destroyed by fire. A nearly complete set of his specimens is in the U. S. National Herbarium at Washington, D. C., and the collection is well represented at the New York Botanical Garden.

Rev. J. Diell, seaman's chaplain at Honolulu, aided Brackenridge materially in his collecting and also did much independently.

On the Galathea Expedition, 1845–7, sent out from Denmark, Didrichsen was the botanist. The larger part of his collections are at Copenhagen; some specimens, however, have reached other herbaria by exchange.

Between 1851 and 1855 Remy made collections for the Paris Museum, some of which may now be seen in the Gray Herbarium at Cambridge, Massachusetts.

In 1864 and 1865 Horace Mann with Dr. William T. Brigham, now Director of the Bernice Pauahi Bishop Museum at Honolulu, spent a year in botanizing over the five larger islands. With the aid of Professor Asa Gray, Mann made an enumeration of the plants found on the islands, which included one hundred and thirteen species of ferns. One set of these specimens is at the Museum in Honolulu and another at Cornell University, Ithaca, New York. Some of the numbers appear in other herbaria.

Many residents in the islands have been interested in the fern flora and have made large collections. The Reverend John M. Lydgate, of Lihue, Kauai, civil engineer and botanist, as well as clergyman, published an enumeration of Hawaiian ferns in 1873, when in college at Oberlin. His later collections have been contributed to Dr. W. Hillebrand's herbarium, now in Berlin. Many of the specimens from Kauai in the Berlin herbarium were collected by Mr. Valdemar Knudsen. The late D. D. Baldwin, at one time professor at Punahou College, has made large collections upon Oahu and Maui. Rev. Edward Bishop was an ardent collector also.

In 1883 Edward Bailey published "Hawaiian Ferns, a Synopsis," a small manual, now out of print. It contained descriptions of six new species.

Dr. William Hillebrand spent twenty years in the Hawaiian Islands, during all of which time he was an enthusiastic botanist. A part of the manuscript of his Flora of the Hawaiian Islands was with the printer at the time of his death, in 1887, and the work was published the following year by his son, Dr. W. F. Hillebrand, now Chief Chemist, Bureau of Standards, Washington, D. C. The herbarium of Dr. William Hillebrand was bequeathed to the Royal Botanical Museum, at Berlin, Germany. The accuracy of his descriptions was shown by the comparison of his specimens with the diagnoses in his Flora. He included one hundred and fifty-five species and many varieties of pteridophytes.

Mr. A. A. Heller, now of the College of Agriculture, Reno, Nevada, made a botanical exploration of Kauai and Oahu in 1895–6 under the auspices of the Minnesota State Geological Survey. The larger part of the collection is at the herbarium of the University of Minnesota, but duplicates have been distributed to several of the larger American institutions and to Kew. A complete set of his vascular cryptogams is at the New York Botanical Garden, as it was sent to Professor L. M. Underwood for determination. The report included one hundred and sixteen species, six of which were new.

In the following summary of the taxonomic study of Hawaiian ferns, diagnoses of the larger groups and also of genera have been given with keys to species, but descriptions of species already published elsewhere have been omitted.

The method in this study has been to examine the specimens as if they represented undescribed species, then to compare them with types so far as possible and with published descriptions. It has been attempted to give the name first used for the plant in Linnaeus' Species Plantarum or the name first published subsequent to 1753.

The writer is indebted to Dr. N. L. Britton, Director of the New York Botanical Garden, for suggestions and criticism, to Mr. William R. Maxon of the U. S. National Herbarium, Smithsonian Institution, Washington, D. C., for the loan of material and helpful criticism, and to Dr. J. H. Barnhart, Librarian of the New York Botanical Garden, for suggestions and criticism as to form, also to Professor A. Engler, Director of the Royal

Botanical Gardens of Berlin, Germany, for permission to study the Hawaiian ferns in the herbarium of the Royal Museum.

PTERIDOPHYTA

Plants (sporophytes) with well-defined vascular tissue, which in the homosporous series produce spores that grow into gametophytes which may be monoecious or dioecious, and in the heterosporous series produce megaspores and microspores; of these the megaspores grow into gametophytes that bear female organs (archegonia), the microspores into gametophytes that bear male organs (antheridia). As the result of the union of the egg cell in the archegonium and a motile male cell (antherozoid) from an antheridium, the sporophyte, ordinarily considered the plant, develops. Reproduction by some form of budding occurs both in the gametophyte and the sporophyte stage of the life history of many species.

Spores in capsules (sporocarps) borne upon the rhizome.	1. SALVINIALES.
Spores borne upon some aerial member of the plant.	
Sporangia not borne in the axils of scalelike leaves.	
Vernation circinate.	
Sporangia separate.	4. FILICALES.
Sporangia coalescent (synangia).	3. MARATTIALES.
Vernation erect or inclined.	2. OPHIOGLOSSALES.
Sporangia borne in the axils of scalelike leaves; these either distant or forming compact strobili.	5. LYCOPODIALES.

1. SALVINIALES

Aquatic or subaquatic plants with horizontal, creeping or floating stems, which bear sporocarps containing megaspores or microspores or both; leaves various.

Plants floating; leaves with entire or 2-lobed blades folded in vernation.	1. SALVINIACEAE.
Plants rooting in the mud; leaves filiform or 2–4-foliate, circinate in vernation.	2. MARSILEACEAE.

1. SALVINIACEAE

Small floating plants, with a more or less elongated, sometimes branching axis. Leaves apparently 2-ranked. Sporocarps 2 or more borne upon a common peduncle; megaspores and microspores in separate sori.

Azolla sp. recently introduced to prevent the breeding of mosquitoes in the ditches along the rice fields.

2. MARSILEACEAE

Perennial plants; leaves 2 or 4-foliate; sporocarps on peduncles which arise with the petioles of leaves or separately from the rootstock and bear megaspores and microspores in the same sorus.

Type species:* *Marsilea quadrifolia* L.

MARSILEA VILLOSA Kaulf. Enum. 272. 1824

TYPE LOCALITY: Oahu, Hawaiian Islands.

DISTRIBUTION: In taro patches, Hawaiian Islands.

SPECIMENS EXAMINED: Hawaiian Islands, *Chamisso* B; *Gaudichaud* B; *Remy* B.

M. villosa is closely allied to *M. vestita* Hook. & Grev. from Oregon and California. Brackenridge referred the American plant to *M. villosa*, but the specimens examined indicate that the Hawaiian plant is a larger and less hairy species than that figured by Hooker and Greville (Ic. Fil. 159. 1829). All specimens in the Berlin herbarium are sterile; Remy's specimen has narrower leaflets and a more compact rootstock than Chamisso's.

SPECIES INQUIRENDA

Marsilea crenulata Desv. Reported by Hillebrand (Fl. Haw. Is. 651. 1888) as collected in Oahu and preserved in the Godet Herbarium. This herbarium is unknown to Dr. W. T. Brigham, director of the Bishop Museum at Honolulu. No specimen was found by the writer in the Berlin herbarium.

2. OPHIOGLOSSALES

Herbaceous, usually succulent plants consisting of a fleshy rootstock with fibrous or fleshy roots and one to several leaves, the latter erect or pendent, non-articulate, simple, lobed, or compound, the blade sessile or stalked; sporophyls simple or ternately compound, arising from the sterile leaf or from the rootstock. Sporangia formed each from a group of epidermal and subepidermal cells, dehiscing by a transverse slit. Prothallia subterra-

* According to the American code of nomenclature the type species of the genus *Marsilea* L. is *Marsilea natans* L. which is based upon *Salvinia* Mich. Nov. Pl. Gen. *pl. 58.* 1729. Under the American code, therefore, the name *Marsilea* L. should be used for *Salvinia* (Micheli) Adans., while the present genus should be called *Lemma* (B. Juss.) Adans.

nean, usually achlorophyllous and nourished by an endophytic fungus.

OPHIOGLOSSACEAE

Characters of the order.

Leaf blade and sporophyl both ternately compound; veins free.	1. *Botrychium.*
Leaf blade simple, sporophyl a distichous spike; veins reticulate.	
Plants terrestrial; leaf blades petiolate.	2. *Ophioglossum.*
Plants epiphytic; leaf blades sessile.	3. *Ophioderma.*

1. BOTRYCHIUM Sw. Jour. Bot. Schrad. 1800[2]: 110. 1801

Terrestrial plants; rootstock short, fleshy, erect; roots clustered, fleshy; sterile leaves 1–3-pinnately compound or decompound; veins free; sporophyls ternately compound; sporangia separate, spherical, sessile, pinnately arranged.

Type species: *Osmunda Lunaria* L.

BOTRYCHIUM SUBBIFOLIATUM Brack. Fil. U. S. Expl. Exp. 317. 1854

TYPE LOCALITY: Hawaii, District of Puna.

DISTRIBUTION: On the ground in wet forests, Hawaiian Islands.

ILLUSTRATIONS: Brack. Fil. U. S. Expl. Exp. *pl. 44.* 1854. PLATE 18.

SPECIMENS EXAMINED: Hawaii, District of Puna, *Wilkes Expedition* (type) N; Oahu, *Lydgate* B; Kauai, *Forbes 262* BM; *Wawra 2061* C; *Remy 62* B; Hawaiian Islands, *Baldwin 114* B, C, N.

The sterile leaf is always asymmetrical, one of the basal pinnae arising above the other.

2. OPHIOGLOSSUM L. Sp. Pl. 1062. 1753

Terrestrial plants; rootstock erect, less than 1 cm. in height; roots fleshy; leaves glabrous; leafstalk fleshy, not articulate; veins anastomosing, with occasional free included veinlets; sporophyl a pedunculate spike, arising from the base of the expanded blade; sporangia in two rows, coalescent.

Type species: *Ophioglossum vulgatum* L.

OPHIOGLOSSUM CONCINNUM Brack. Fil. U. S. Expl. Exp. 315. 1854

TYPE LOCALITY: Sand hills, near Wailuku, Maui, Hawaiian Islands.

DISTRIBUTION: On ground, appearing after rains; often near the seashore or in soil that has been taken from the shore; Hawaiian Islands.

ILLUSTRATION: Brack. Fil. U. S. Expl. Exp. *pl. 44. f. 1.* 1854.

SPECIMENS EXAMINED: Maui, *Hillebrand* B; Oahu, *Forbes* BM; *Remy* B; Hawaiian Islands, *Baldwin 113* B, C.

The point of divergence between the leaf and sporophyl is on the petiole in *O. nudicaule* Sw. (Syn. Fil. *pl. 4. f. 2.* 1806), while in *O. concinnum* Brack. it is at the base of the blade; the blade is ovate in *O. nudicaule* rather than elliptical as in *O. concinnum*, and there is no trace in the Hawaiian plant of the midrib mentioned for *O. ellipticum* (Hook. & Grev. Ic. Fil. *pl. 40.* 1831). All these forms, however, are closely related.

3. OPHIODERMA (Bl.) Endl. Gen. Pl. 66. 1836

Epiphytic plants; rootstock erect, less than 1 cm. high; roots fleshy; leaves not articulate, strap-shaped, sessile, fleshy, brittle; venation reticulate, without free included veinlets; sporophyl a two-ranked spike of coalescent sporangia, arising from the middle of the blade.

Type species: *Ophioglossum pendulum* L.

OPHIODERMA PENDULUM (L). Presl, Suppl. Tent. Pterid. 56. 1845

Ophioglossum pendulum L. Sp. Pl. ed. 2. 1518. 1763.

TYPE LOCALITY: Amboina, Molucca Islands.

DISTRIBUTION: On trees or fallen logs, at elevations of 600–1,500 m.; Asia, Australia, Polynesia.

ILLUSTRATIONS: Hook. & Grev. Ic. Fil. *pl. 19.* 1831; Rumpf. Amb. *pl. 37. f. 3.* 1741.

SPECIMENS EXAMINED: Hawaii, *Robinson 212* V; *Wilkes Expedition* N; Maui, *Lichtenthaler* N; *Robinson 304* V; *320* V; Oahu, *Heller 2217* C, N; *Robinson 8* V; *43* V; *111* V; *115* V; *Safford 920* N; Kauai, *Robinson 429* V; *443* V; Hawaiian Islands, *Baldwin 112* B, C; *Miss Sessions* C; ex Herb. John Donnell Smith *618* N.

3. MARATTIALES

Plants herbaceous, consisting of a fleshy or tuberous rootstock, soft fleshy roots, and cespitose, stipulate, bipinnate to tripinnate leaves, which are articulate upon the stem and circinate in

vernation; veins free; sporangia developed from a group of epidermal and subepidermal cells, separate or coalescent, in the latter case forming boat-shaped or circular synangia. Prothallia green, thalloid, large.

MARATTIACEAE

Characters of the order.

MARATTIA Sw. Prod. Fl. Ind. Occ. 128. 1788

Rootstock tuberous, starchy; leaf blades deltoid, dark green, thick, glabrous, bipinnate to tripinnate; stipules two, fleshy, at the base of the fleshy leafstalk; venation free; sporangia near the ends of the veins, coalescent, forming synangia upon a slightly elevated receptacle; these in some species subtended by a pseudo-indusium.

Type species: *Marattia alata* Sw.

MARATTIA DOUGLASII (Presl) Baker; Hook. & Baker, Syn. Fil. 441. 1868

Marattia alata Hook. & Arn. Bot. Beech. 102. 1832. Not *M. alata* Sw. 1788.

Stibasia Douglasii Presl, Suppl. Tent. Pterid. 16. 1845.

Gymnotheca Douglasii Moore, Ind. Fil. 121. 1857.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: In moist, shady localities, above 600 m. elevation, Hawaiian Islands.

ILLUSTRATION: Vriese, Mon. Marat. *pl. 4.* 24. 1853.

SPECIMENS EXAMINED: Hawaii, *Robinson 202* V; Maui, *Robinson 329* V; Oahu, *Diell* C; Kauai, *Heller 2770* C, N; *Lichtenthaler* N; Hawaiian Islands, *Baldwin 111* C, N; *Wilkes Expedition* C; *Hitchcock* C; ex Herb. Mt. Holyoke College C; ex Herb. John Donnell Smith N.

The fleshy tubers taste somewhat like a turnip and are eaten either raw or baked by the native Hawaiians.

4. FILICALES

Plants terrestrial or epiphytic (aquatic in Ceratopteridaceae), varying in habit from minute herbaceous forms to arboreous

forms; sporangia developed from a single epidermal cell, mainly upon the under surface of the leaf, in clusters (sori) upon the veins, or within marginal indusia, or less commonly, scattered over the entire lower surface or upon non-foliose sporophyls. Indusia various or wanting. Prothallia chlorophyllous, thalloid.

Sporangia borne in a distichous spike; sterile leaves slender, grasslike. — 1. SCHIZAEACEAE.

Sporangia associated in indusiate or non-indusiate sori or scattered over the lower surface of the leaf.

Leaves pseudo-dichotomous, usually with a bud between the paired divisions, giving the appearance of indefinite growth; sori non-indusiate, small, circular. — 2. GLEICHENIACEAE.

Leaves simple, pinnately divided, or ternately divided.

Sori valvate or tubular.

Sori valvate, the outer valve formed by a coriaceous outgrowth from the margin of the leaf, dorsal upon the veins; plants arboreous. — 3. CYATHEACEAE.

Sori valvate or tubular, not coriaceous; terminal upon the veins; plants delicate, mostly epiphytic. — 4. HYMENOPHYLLACEAE.

Sori not valvate or tubular; indusium various or absent. — 5. POLYPODIACEAE.

1. SCHIZAEACEAE

Plants of diverse form and habit, including xerophilous forms with simple leaves and climbing plants with lobed or divided leaves. Sporangia borne singly or in rows on more or less specialized terminal segments, or upon the very slender non-foliose pinnae, indusiate or non-indusiate; annulus subapical, distally contracted; dehiscence longitudinal. Prothallia foliose or filamentous and branched.

SCHIZAEA J. E. Smith, Mém. Acad. Turin **5**: 419. 1793

Rootstock short, upright, covered with dark brown scales; leaves linear, grasslike; sporophyl consisting of a long slender stalk and a digitate fertile portion folded upon the midrib; sporangia borne in two rows upon each division.

Type species: *Schizaea dichotoma* J. E. Smith.

SCHIZAEA ROBUSTA Baker; Hook. & Baker, Syn. Fil. ed. 2. 429. 1874

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: At high elevations in marshes and occasionally in exposed localities, Hawaiian Islands.

SPECIMENS EXAMINED: Oahu, *Forbes 1038* BM; *Lichtenthaler* N; *Mann & Brigham 475* N; *Wilkes Expedition* N; Kauai, *Heller 2246* C, N; *Robinson 419* V; *452* V; Hawaiian Islands, *Baldwin 115* C, N; *Baldwin* (ex Herb. Hillebrand) C; *Baldwin* (ex Herb. Mt. Holyoke College) C.

This is the species wrongly referred by Brackenridge (Fil. U. S. Expl. Exp. 302. 1854) to *S. australis* Gaud., a plant from the Falkland Islands, described by Gaudichaud (Ann. Sci. Nat. 5: 98. 1825).

Heller (Minn. Bot. Stud. 1: 789. 1907) says: "The first specimens were collected at an elevation of perhaps 762 m., on Konahuanui, Oahu, on a little spot in clay formation. The plants were small and stunted. It was found on the opposite side of the valley on the slope of Waiolani, at the same elevation. Near the Wahiawa bog, on Kauai, large and beautiful specimens were obtained." Mr. C. N. Forbes' specimen (*Forbes 1038* BM) collected at the extreme western ridge of Konahuanui, "a dry ridge in broad sunlight," is small and stunted though it has developed sporangia, while specimens from the Wahiawa bog above McBride's mountain house (*Robinson 419* V and *452* V) are large and fine.

2. GLEICHENIACEAE

Terrestial, xerophilous plants, with erect or creeping rootstocks. Leaves non-articulate, distant or cespitose, mostly consisting of an erect or ascending primary leafstalk of indeterminate growth, forking into one to several opposite divisions, these simple and determinate or one to several times dichotomous. Sori dorsal or terminal upon the veins, non-indusiate; sporangia sessile, subglobose to pyriform; annulus nearly complete, obliquely transverse; dehiscence vertical.

The family Gleicheniaceae is represented by several species of the genus *Dicranopteris*, which form nearly impenetrable

thickets upon the mountain sides and sometimes in the valleys also. The attachment of the roots to the thin soil is very insecure and the man or beast that ventures to step upon the seemingly solid mass, where it has overgrown the trail in the mountains, may feel it give way, allowing him to slip far down the steep slope. *Dicranopteris* is known locally as stag-horn fern and is a pest in the cattle-raising districts, as stock refuse to graze upon it.

DICRANOPTERIS Bernh. Neues Jour. Bot. Schrad. 1^2: 38. 1806

Rootstock creeping, much branching, 0.5–1 cm. in diameter; leafstalk 1–2 m. high, not articulated to the rootstock; rachis of indeterminate growth, bearing opposite lateral branches in acropetal succession, these simple or repeatedly forked; included buds sometimes developing axes similar to the primary; ultimate divisions pectinate, pinnate, or bipinnate; veins free; sori dorsal upon the veins, non-indusiate; sporangia sessile; annulus obliquely transverse, the dehiscence vertical.

Type species: *Polypodium pectinatum* Thunb.

Ultimate divisions bipinnate, the leafstalk not forked.
- Pinnules sessile, the lower segments lobed and overlapping the rachis; leafstalk noticeably scaly. *D. glauca.*
- Pinnules stalked, the lower segments entire; leafstalk with few scales. *D. glabra.*

Ultimate divisions (pinnae) pectinate, in pairs; the leafstalk once or several times forked.
- A pair of accessory, deflexed, equal or unequal pinnae borne at all except the ultimate forkings of the leafstalk; veins 2–5-forked; segments mostly emarginate, connected by wing along rachis; sori 5–12-sporangiate.
  - Segments densely tomentose when young, somewhat less so with age; texture rigid; emarginate character of pinnules constant; sori mostly 8-sporangiate or less. *D. emarginata.*
  - Segments glabrous or nearly so; texture chartaceous; emarginate character of pinnules not constant; sori usually 12-sporangiate. *D. linearis.*
- Accessory pinnae wanting; segments not emarginate, nearly or quite free; rachis scaly; veins mostly once forked; sori 2–5-sporangiate. *D. owhyhensis.*

DICRANOPTERIS GLAUCA (Thunb.) Underw. Bull. Torrey Club **34**: 249. 1907

Polypodium glaucum Thunb.; Houtt. Nat. Hist. **14**: 177. 1783.
Mertensia glauca Sw. Sv. Vet.-Akad. Handl. II. **25**: 177. 1804.

Gleichenia longissima Blume, Enum. Pl. 250. 1828.
Mertensia pinnata Kunze, Anal. Pterid. 6. 1837.
Mertensia excelsa J. Sm. Lond. Jour. Bot. 2: 381. 1843.
Gleichenia glauca Hook. Sp. Fil. 1: 4. 1844.
Hicriopteris speciosa Presl, Epim. 27. 1849.

TYPE LOCALITY: Java.

DISTRIBUTION: China, Japan, Malaysia, Tropical Australia, and Polynesia.

ILLUSTRATION: Hook. Sp. Fil. *pl. 3B.* 1844.

SPECIMENS EXAMINED: Maui, *Bailey* C; Molokai, *Hillebrand* B; Oahu, *Hillebrand* B; *Macrae* B; *Robinson 501* V; *504* V; Kauai, *Hillebrand* B, C.

D. glauca is found in fruit somewhat rarely. Both the bipinnate species are less common than *D. linearis* and grow at higher elevations.

DICRANOPTERIS GLABRA (Brack.) Underw. Bull. Torrey Club 34: 249. 1907

Mertensia glabra Brack. Fil. U. S. Expl. Exp. 292. 1854.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Above 600 m. on wet mountain slopes, Hawaiian Islands.

SPECIMENS EXAMINED: Oahu, *Hillebrand* B; *Robinson 55* V; Kauai, *Forbes 107* BM; *Heller 2613* C; Hawaiian Islands, ex Herb. Eaton C.

Dicranopteris emarginata (Brack.) comb. nov.

Mertensia emarginata Brack. Fil. U. S. Expl. Exp. 297. 1854.

TYPE LOCALITY: Hawaii.

DISTRIBUTION: Open mountain ridges, Hawaiian Islands.

ILLUSTRATIONS: Brack. Fil. U. S. Expl. Exp. *pl. 42. f. 1a, 1b.* 1854.

SPECIMENS EXAMINED: Oahu, *Robinson 40* V; Hawaiian Islands, *Hillebrand* K; *Wilkes Expedition* C.; ex Herb. Eaton C; *Lindley* C.

DICRANOPTERIS LINEARIS (Burm.) Underw. Bull. Torrey Club 34: 250. 1907

Polypodium lineare Burm. Fl. Ind. 235. 1768.
Polypodium dichotomum Thunb. Fl. Jap. 338. 1784.

Mertensia dichotoma Willd. Sv. Vet.-Akad. Handl. II. **25**: 167. 1804.
Dicranopteris dichotoma Bernh. Neues Jour. Schrad. 1[2]: 38. 1806.
Gleichenia linearis Clarke, Trans. Linn. Soc. II. 1: 428. 1880.

TYPE LOCALITY: Java.

DISTRIBUTION: Forming thickets at from 200–1,000 m. elevation, tropical countries.

ILLUSTRATIONS: Burm. Fl. Ind. *pl. 67. f. 2.* 1768; Thunb. Fl. Jap. *pl. 37.* 1784.

SPECIMENS EXAMINED: Hawaii, *Hillebrand* B; *Robinson 240* V; Maui, *Bailey* B, C; *Robinson 316* V; Oahu, *Didrichsen 3772* C; *Forbes* BM; *Robinson 24* V; Kauai, *Forbes 80* BM; *Heller 2761* C; Hawaiian Islands, *Baldwin 1* C; *Wilkes Expedition* C; ex Herb. Eaton C; ex Herb. Mt. Holyoke College C.

Dicranopteris owhyhensis (Hook.) comb. nov.

Gleichenia owhyhensis Hook. Sp. Fil. 1: 9. 1844.
Mertensia hawaiiensis Brack. Fil. U. S. Expl. Exp. 295. 1854.
Gleichenia hawaiiensis Hilleb. Fl. Haw. Is. 544. 1888.

TYPE LOCALITY: Byron Bay, Oahu, Hawaiian Islands.

DISTRIBUTION: At elevations of 1,500–2,000 m., rare; Hawaiian Islands.

SPECIMENS EXAMINED: Maui, *Bailey* C; *Hillebrand* B; Oahu, *Baldwin 9* B; *Hillebrand* B; *Heller* C; Kauai, *Hillebrand* B; *Robinson 407* V; *410* V; Hawaiian Islands, *Baldwin 2* C; *Macrae* B, C.

The name is derived from an early spelling of Oahu; the type was collected upon this island by Macrae.

3. CYATHEACEAE

Mainly arboreous plants of the humid elevated regions of the tropics; rootstock stout and erect or decumbent; leaves cespitose, usually twice or more pinnate, rarely simple, articulate or non-articulate; leaf blades mostly one to several meters long; sori globose, dorsal or terminal upon the veins, indusiate or non-indusiate; sporangia usually numerous, ovoid, the annulus complete and oblique, with or without a definite orifice; dehiscence horizontal.

The family Cyatheaceae is represented in the Hawaiian flora

by a single genus, *Cibotium*, which forms a conspicuous part of the fern forest in the region of the active volcano Kilauea, on Hawaii, and appears above 600 m. elevation on the other islands, though, doubtless, its size is greatest in the forests below Kilauea, in Puna and Olaa. Three species are associated in this locality, and these apparently intergrade.

Trunks of *Cibotium* have been used to make fences by placing them side by side like a palisade, and as they regenerate their crowns they make a most effective enclosure. On Mr. Snow's estate at Glenwood, 22 miles from Hilo, walks have been made of boards sawed from fern trunks, probably of *C. Menziesii*, which contain some boards 1 m. in width. On this estate and on the Hitchcock place adjoining, *C. Menziesii* growing in the open has attained a height of 16 m. or more.

The wooly scales at the base of the leafstalks, known commercially as pulu, were used formerly to a considerable extent as stuffing for mattresses, and the pulu-gatherers were ruthless in their destruction of old trees to obtain this commodity. Now, however, pulu has fallen into disuse and is no longer exported.

CIBOTIUM Kaulf. Jahrb. Pharm. **21**: 53. 1820

Pinonia Gaud. Ann. Sci. Nat. **3**: 507. 1824.

Rootstock usually arborescent with numerous large, chaffy scales at the apex; leafstalks not articulate; blades deltoid-ovate, bipinnate to quadripinnate, the pinnules stalked; sori valvate capsules, consisting of a cuplike outgrowth from the margin of the lobe of the pinnule and the indusium, which forms a lidlike covering. Sporangia stalked.

The leaves of all Hawaiian species are tripinnate.

Type species: *Cibotium Chamissoi* Kaulf.

Caudex 4–8 m. high; leafstalk 3–4 m. long, covered with soft, brown scales at the base, with black, hairlike scales above; blades 3–4 m. long; sinuses between the segments of the pinnules broad, shallow, often margined with sori; fertile veins mostly simple, usually 7 or less to a segment. *C. Menziesii.*

Caudex less than 3 m. high, usually about 2 m. high; leafstalk clothed at the base with soft, brownish scales, upper portion naked; blades less than 3 m. long; sinuses between segments of pinnules narrow, acute; fertile veins simple or once forked.

Lower surface of blade dull glaucous, for the most part strongly tomentulose; veins 6–8 to a segment, simple or forked. *C. Chamissoi.*

Lower surface of blade conspicuously glaucous, for the most part slightly tomentulose, becoming glabrous; veins 9–10 to a segment, usually 1–2-forked. *C. glaucum.*

CIBOTIUM MENZIESII Hook. Sp. Fil. **1**: 84. 1844

Dicksonia Menziesii Hook. & Baker, Syn. Fil. 49. 1866.

TYPE LOCALITY: Oahu, Hawaiian Islands.

DISTRIBUTION: On ground at 600–1,250 m. elevation; usually found with lehue and other hardwood trees, in a damp forest; Hawaiian Islands.

ILLUSTRATION: Hook. Sp. Fil. **1**: *pl. 29c.* 1844.

SPECIMENS EXAMINED: Molokai, *Hillebrand* B, C; Oahu, *Beechey* K, C; *Forbes* BM; *Robinson 707* V; Kauai, *Heller 2693* C; Hawaiian Islands, *Baldwin 5* B, C, N; *Wilkes Expedition* C.

The ohia-lehue (*Metrosideros villosa* Sm.) often succeeds *Cibotium* in the forest by germinating in the crown of the fern, sending down its roots along the moist trunk and finally shutting out the light entirely, so that in time the fern dies and the lehue is left with what is apparently a hollow and fissured trunk.

Heller 2590 may be a cross between *C. Menziesii* and *C. Chamissoi*, in which more of the dominant characters belong to the former than to the latter.

CIBOTIUM CHAMISSOI Kaulf. Berl. Jahrb. Pharm. **21**: 53. 1820

Pinonia splendens Gaud. Ann. Sci. Nat. **3**: 507. 1824.
Dicksonia splendens Desv. Prod. 318. 1827.
Cibotium pruinatum Mett. in Kuhn, Linnaea **36**: 150. 1869.

TYPE LOCALITY: Oahu.

DISTRIBUTION: On the wooded slopes of mountains, at elevations of 600–1,200 m., Hawaiian Islands.

ILLUSTRATIONS: Kaulf. Enum. *pl. 1. f. 14.* 1824; Hook. Ic. Pl. **17**: *pl. 1603.* 1886.

SPECIMENS EXAMINED: Hawaii, *Lichtenthaler* N; Oahu, *Beechey* B; *Bennett* B; *Chamisso* B; *Gaudichaud* B; *Heller 2898* C; *Robinson 35* V; *Safford 875* N; Kauai, *Heller 2600* C, K; *Knudsen 36* B; Molokai, *Hillebrand* B, C; Hawaiian Islands, *Baldwin* B; *Gaudichaud* B, C; *Lydgate* B; *Wilkes Expedition* C, N.

CIBOTIUM GLAUCUM (J. E. Smith) Hook. & Arn. Bot. Beech. 108. 1841

Dicksonia glauca J. E. Smith, in Rees, Cyc. 11. 1819.

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: Somewhat rare, on moist, wooded mountain slopes and wet flats, at 300–900 m. elevation.

ILLUSTRATIONS: Hook. Sp. Fil. 1: *pl. 29A*. 1841; Bed. Ferns Brit. Ind. *pl. 83*. 1865.

SPECIMENS EXAMINED: Hawaii, *Beratz* B; *Lydgate* B; *Robinson 201* V; *207* V; Maui, *Bailey* C; Molokai, *Hillebrand* B; C; Oahu, *Beechey* C, K; *Diell* C, K; *Baldwin* N; Kauai, *Forbes 34* BM; *356* BM; *Heller 2818; Knudsen* B; *Lydgate* B; *Mann & Brigham 543* N; Hawaiian Islands, *Baldwin 4a* B; *4* C; ex Herb. Mt. Holyoke College C; ex Herb. John Donnell Smith N; *Wilkes Expedition 1* C.

4. HYMENOPHYLLACEAE

Delicate ferns, the leaf blades seldom more than one layer of cells in thickness except at the veins; found in very moist localities, usually above 500 m. in elevation in the tropics. Rootstock slender, creeping or suberect; leaf blades much divided; sporangia sessile upon a filiform, usually elongated receptacle within an urn-shaped, tubular, or two-lipped marginal indusium, or protruding beyond it; annulus complete, transverse, opening vertically.

Receptacle filiform, projecting beyond the indusium.	1. *Trichomanes.*
Receptacle shorter than the indusium, or barely protruding.	2. *Hymenophyllum.*

1. TRICHOMANES L. Sp. Pl. 1097. 1753

Rootstock slender, creeping, or suberect; leaves pinnatifid to tripinnate; veins free; sori terminal upon the veins; indusium tubular or urn-shaped, occasionally 2-lipped; sporangia sessile, arranged spirally upon the receptacle, which usually projects from the margin of the leaf like a trichome.

Type species: *Trichomanes crispum* L.

Stem erect; leafstalk and midrib fibrillose; plants mostly terrestrial.	*T. Bauerianum.*
Stem creeping; plants mostly epiphytic, smooth or nearly so.	
Leaf palmate or orbicular, less than 2 cm. high.	*T. parvulum.*
Leaf not palmate nor orbicular, more than 2 cm. high.	

Leaf light green, less than 6 cm. high, lanceolate or oblong-lanceolate. *T. humile.*
Leaf dark green, more than 6 cm. high.
Leaf deltoid. *T. cyriotheca.*
Leaf irregular in outline, usually narrowing below. *T. radicans.*

TRICHOMANES BAUERIANUM Endl. Prod. Fl. Norf. 17. 1833

Trichomanes apiifolium Presl, Hym. **16**: 44. 1843.
Trichomanes eminens Presl, Hym. **16**: 44. 1843.
Trichomanes myrioplazium Kunze, Bot. Zeit. **4**: 477. 1846.
Trichomanes meifolium Brack. Fil. U. S. Expl. Exp. 259. 1854.

TYPE LOCALITY unknown.

DISTRIBUTION: On ground in wet forests; Polynesia.

SPECIMENS EXAMINED: Hawaii, *Beratz* B; *Wilkes Expedition* B, C; Molokai, *Hillebrand* B; Maui, *Robinson 381* V; Oahu, *Forbes* BM; *Macrae* B; *Robinson 507* V; Kauai, *Heller 2179* B; *2741* B; *Johnson* B; *Remy 51* B; *Robinson 469* V.

The bilabiate form of the indusium of *T. Bauerianum* Endl. gives the appearance of *Hymenophyllum* to the young leaves, but the projecting vein with its attached sporangia and the urn-shaped form of the mature sporangium place the species in the genus *Trichomanes.*

TRICHOMANES PARVULUM Poir. in Lam. Encyc. **8**: 33. 1808

Trichomanes sibthorpioides Gaud. Bory in Willd. Sp. Pl. **5**: 498. 1810.
Trichomanes bifolium Bl. Enum. Pl. 223. 1828.
Trichomanes minutum Bl. Enum. Pl. 224. 1828.
Trichomanes saxifragoides Presl, Hym. 39. 1843.
Gonocormus saxifragoides v. d. Bosch, Hym. 9. 1861.

TYPE LOCALITY unknown.

DISTRIBUTION: Somewhat rare, on tree trunks in moist woods at 600–1,000 m. elevation; Polynesia.

ILLUSTRATION: Hook. Sp. Fil. **1**: 39. 1844.

SPECIMENS EXAMINED: Maui, *Bailey* C; Oahu, *Forbes 1083* BM; *Robinson 53* V; *502* V; *509* V; Hawaiian Islands, *Baldwin 106* B; *107* C; *Hillebrand* B; C; *Wilkes Expedition* C.

The dark green fronds appressed upon the tree trunks or upon the rocks where water is trickling over them, make a beautiful

matted covering, which resembles a liverwort in general appearance.

TRICHOMANES HUMILE Forst. Prod. 84. 1786

Trichomanes minutulum Gaud. Freyc. Voy. Bot. 377. *pl. 12. f. 2.* 1827.

Didymoglossum humile Presl, Hym. 23. 1843.

Trichomanes Endlicherianum Presl, Abh. Böhm. Ges. **5**: 333. 1848.

Trichomanes Draytonianum Brack. Fil. U. S. Expl. Exp. 252. 1854.

TYPE LOCALITY: Society Islands.

DISTRIBUTION: On tree trunks in moist woods; Polynesia, Java, Formosa, New Zealand, Australia.

ILLUSTRATIONS: Presl, Epim. 10. *pl. 5A.* 1849; v. d. Bosch, Hym. Java *pl. 11.* 1861; Brack. Fil. U. S. Expl. Exp. *pl. 36.* 1854.

SPECIMENS EXAMINED: Maui, *Bailey* C; Oahu, *Robinson 55* V; *99* V; Kauai, *Heller 2556* C; Hawaiian Islands, *Baldwin 108* C; *Remy 83* B; *Wilkes Expedition 9* B, C.

TRICHOMANES CYRTOTHECA Hilleb. Fl. Haw. Is. 636. 1888

TYPE LOCALITY: Kahana, Oahu.

DISTRIBUTION: Above 600 m. elevation; Hawaiian Islands, in wet woods.

ILLUSTRATION: PLATE 19.

SPECIMENS EXAMINED: Maui, *Bailey* C; Oahu, *Hillebrand* B; *Robinson 107* V; Hawaiian Islands, *Baldwin* B; *Baldwin 106* C.

The color and size of the leaves are similar in *T. cyrtotheca* and *T. radicans* and both grow in deep wet forests, but they may be distinguished by the deltoid form of the leaf blade, the curving of the sori, and the smaller size of the rootstock of the former and the irregular outline, blunt pinnae with sori subimmersed, and thicker rhizome of the latter.

TRICHOMANES RADICANS Sw. Jour. Bot. Schrad. **1800**[2]: 97. 1801

Trichomanes speciosum Willd. Sp. Pl. **5**: 514. 1810.

Trichomanes davallioides Gaud. Bot. Freyc. Voy. 3. 1827.

Trichomanes sandvicense v. d. Bosch, Ned. Kr. Arch. **5**[2]: 165. 1861.

TYPE LOCALITY: West Indies.

DISTRIBUTION: Tropical countries, Ireland, Wales.

ILLUSTRATION: PLATE 20.

SPECIMENS EXAMINED: Hawaii, *Robinson 250* V; *270* V; *290* V; Maui, *Bailey* C; *Robinson 310* V; Oahu, *Didrichsen* C; *Forbes 95* BM; *Heller 2119* C; *Macrae* B; *Robinson 76* V; *108* V; Kauai, *Hillebrand* B; Hawaiian Islands, *Baldwin 109a* B, C; *Bennett* B; *Gaudichaud* B; *Lydgate* B; *Remy 52* B; *Wilkes Expedition 12* B, C (cotype of *T. sandvicense* v. d. Bosch).

Sir James E. Smith says "Few plants of any country have caused more enquiry or more diversity of opinion than this fern," and the variations in the Hawaiian forms of this species might add much material for such discussion.

2. HYMENOPHYLLUM J. E. Smith, Mém. Acad. Turin **5**: 418. 1793

Rootstock slender, creeping; leaves pinnatifid to bipinnatifid, glabrous or hairy; sori terminal upon the veins; indusium bilabiate, formed by the division of the tissue of the margin of the leaf; receptacle seldom exserted.

Type species: *Hymenophyllum tunbridgense* (L.) Sm.

Stem upright; leaves tufted, lanceolate; leafstalk clothed with reddish hairs. *H. Baldwinii.*

Stem creeping; leaves not tufted.

- Leaves glabrous, the apexes usually curving downward. *H. recurvum.*
- Leaves hairy, the apexes vertical.
  - Leaves rhomboid or obtuse-ovate, covered with reddish brown stellate hairs. *H. obtusum.*
  - Leaves lanceolate, bearing simple hairs on margin and veins. *H. lanceolatum.*

HYMENOPHYLLUM BALDWINII D. C. Eaton, Bull. Torrey Club **6**: 293. 1879

TYPE LOCALITY: Oahu.

DISTRIBUTION: On trees, above 800 m. elevation, in a lateral valley of Nuuanu, which leads up to Konahuanui.

SPECIMENS EXAMINED: ex Herb. D. C. Eaton (cotype) C; *Baldwin 110* C; *Baldwin* V.

HYMENOPHYLLUM RECURVUM Gaud. Voy. Freyc. Bot. 376. 1832

TYPE LOCALITY: Maui, Hawaiian Islands.

DISTRIBUTION: On trees above 600 m. elevation, Hawaiian Islands.

ILLUSTRATION: Hook. Sp. Fil. 1: *pl. 37.* 1844.

SPECIMENS EXAMINED: Hawaii, *Robinson 209* V; *215* V; Maui, *Bailey C; Robinson 311* V; *317* V; *326* V; Oahu, *Diell* C; *Heller 2603* C; *2620* C; *Hillebrand* C; *Macrae* B; *Robinson 39* V; *508* V; *Forbes* BM; Kauai, *Forbes 113* BM; *Hillebrand 152* B; *Robinson 835* V; Hawaiian Islands, *Baldwin 102* C; *Beechey* C; *Gaudichaud 195* B; *Lindley* C; *Wilkes Expedition 15* B, C.

Hymenophyllum recurvum is a very graceful fern, which forms a light green covering upon the tree trunks and wet rocks in deep, shady glens.

HYMENOPHYLLUM OBTUSUM Hook. & Arn. Bot. Beech. 109. 1832

TYPE LOCALITY: Oahu.

DISTRIBUTION: On trees, in wet forests, Hawaiian Islands; also reported from New Guinea and Cape of Good Hope.

ILLUSTRATION: Hook. Sp. Fil. 1: *pl. 37D.* 1844.

SPECIMENS EXAMINED: Molokai, *Hillebrand* B; Oahu, *Heller 2229* C; *2910* C; *Robinson 10* V; *37* V; *503* V; Hawaiian Islands, *Baldwin 104* C; *Wilkes Expedition* C.

HYMENOPHYLLUM LANCEOLATUM Gaud. Voy. Freyc. Bot. 109. 1832

TYPE LOCALITY: Hawaiian Islands.

DISTRIBUTION: On tree trunks in Hawaiian Islands.

ILLUSTRATION: Hook. Sp. Fil. *pl. 34.* 1844.

SPECIMENS EXAMINED: Hawaii, *Robinson 273* V; *278* V; Maui, *Bailey* C; Oahu, *Heller 2256* C; *2705* C; *Macrae* B; *Robinson 70* V; *94* V; *96* V; *125* V; Kauai, *Robinson 404* V; *406* V; *830* V; Hawaiian Islands, *Baldwin 103* C; *Douglas* B; *Gaudichaud* B; *Wilkes Expedition* B; C.

The fronds soon become bronze in color, partly from the hairiness of their surface, by which, as well as by their size, they are easily distinguished from *H. recurvum.*

The following specimens are smaller than the others and bear only marginal hairs: *Heller 2705, Robinson 302, 404, 406, 830.*

INDEX TO AMERICAN BOTANICAL LITERATURE

(1910-1912)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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